

Chapter 2.1 STATE BACKGROUND INFORMATION

Population

The Commonwealth of Virginia covers 40,741 square miles, ranking 36th among the states in size. This area is divided into six Department of Environmental Quality (DEQ) regional offices and two satellite offices (Figure 2.1-1). According to the most recent census (1994), the population of the Commonwealth was estimated to be 6,551,500; 2.5% of the total United States population. It has grown 18.3% between 1980 and 1994, ranking 12th nationally, and continues to grow. About 72% of all Virginians live in eight metropolitan areas; Northern Virginia, Norfolk-Virginia Beach-Newport News, Richmond-Petersburg, Roanoke, Lynchburg, Charlottesville, Danville, Johnson City-Kingsport-Bristol. Nine percent of the population lives in seven smaller urban areas and 19% live in rural areas.

Geography

Virginia is over 400 miles wide along its southern boundary, reaching from the Atlantic Ocean in the east, crossing the eastern continental divide into the Mississippi Basin to the west. Along the way, Virginia crosses five physiographic provinces (Figure 2.1 -2). The southwestern edge of the state touches upon the margin of the Cumberland Plateau, rugged terrain with formations of sandstone and shale. Virginia's coal mining industry is concentrated in this area. The Valley and Ridge province encompasses the long, parallel ridges of the Appalachian Mountain chain in western Virginia. Erosion resistant quartzites and sandstones form the ridgetops, while streams have carved valleys into the softer limestones and shales. The narrow Blue Ridge Mountain province is made up of hard greenstone, quartzites, and granites, igneous and metamorphic rocks that originated as ancient lava flows. These mountains are among the oldest on earth. East of the Blue Ridge Mountains lies the rolling Piedmont of central Virginia. This area is underlain by a complex of igneous and metamorphic rocks. The Triassic Basins, ancient down-faulted basins filled with sedimentary rocks and igneous intrusions are major sub-units of this province. A distinctive fall line, marked by waterfalls and rapids across the major rivers, divides the Piedmont from the Coastal Plain. Virginia's flat Tidewater area consists of deep, unconsolidated deposits of sand, gravel, fossil shells, and clay. The basement formation of granite, exposed at the fall line, is buried under 2,900 feet of sediment at the Atlantic Coast.

Water Resources

A summary of Virginia's water resources is provided in Table 2.1-1. Virginia has an estimated 49,350 miles of streams and rivers divided into nine major basins (Figure 2.1 - 3). This estimate represents mileage determined by EPA's River Reach File 3, the Digital Line Graph database as well as estimates from Virginia's Stream Gazetteer. Annual rainfall averages almost 43 inches. Total combined flow of all freshwater streams in the state is estimated at about 25 billion gallons per day. The 248 publicly owned lakes in the Commonwealth have a combined area of 162,230 acres. Three large impoundments (Lakes Gaston, Kerr, and Smith Mountain) account for two-thirds of this total. Many thousands of other small, privately held lakes and ponds, some of significant size, dot the landscape.

Other significant water features of Virginia include approximately 236,900 acres of tidal and coastal wetlands, 808,000 acres of freshwater wetlands, 120 miles of Atlantic Ocean coastline, and over 2,500 square miles of estuaries. Virginia's highly indented shoreline, including the Chesapeake Bay and its sub-estuaries, is conservatively estimated to be 3,315 miles long.

Table 2.1 - 1 Virginia Water Resources Atlas

State Population (1994 census) - 6,551,500		
State Surface Area - 40,741 square miles		
Major River Basins		
Potomac/Shenandoah James York Roanoke Chowan/Dismal Swamp	Tennessee/Big Sandy Chesapeake Bay/Small Coastal Rappahannock New	
Perennial River Miles	49,350	
Total Non-Tidal Stream Miles	49,350	
Miles of Border River (Potomac) - 180		
Publicly-Owned Lakes and Reservoirs	<u>Number</u>	<u>Acres</u>
Greater than 5,000 acres	5	109,838
Less than 5,000 acres	243	52,392
Total	248	162,230
Acres of Freshwater Wetlands - 808,000		
Acres of Tidal and Coastal Wetlands - 236,900		
Estuary Square Miles - 2,500		
Atlantic Ocean Coastal Miles - 120		
Total Coastal Shoreline Miles, including Chesapeake Bay and Tidal Tributaries to a Width of 110 Feet - 3,315		
Statewide Average Annual Rainfall - 42.8 inches		
Average Freshwater Discharge of All Rivers - Approximately 25 billion gallons per day		

Land Use

Virginia's landscape is dominated by its forests, covering approximately 55.6% of its total area (Table 2.1-2). However, according to the Virginia Department of Forestry, a loss of commercial forest and cropland has contributed to an increase in urban land from 10.4% to 14.8% from 1991 to 1995.

The second most prevalent land use in Virginia is agriculture, covering 25.9 percent of the State's total land area. Cropland accounts for 2,903 square miles, about 7.1 percent of the State's total area; pasture and hay production accounts for 6,845.3 square miles, or about 16.8 percent of

the State's land. The remaining 6,029 square miles of land area, about 14.8 percent of the State,

Land Use

Commercial Forests	20,058.6 mi ²	49.2%
National Forests	2,550.0 mi ²	6.4%
Total Forested Land	22,608.6 mi²	55.6%
Cropland	2,903.4 mi ²	7.1%
Pasture/Hay	6,845.3 mi ²	16.8%
Other	828.1 mi ²	2.0%
Total Agricultural Land	10,576.8 mi²	25.9%
Other (Including Urban)	6,029.1 mi²	14.8%
Total Land Area	39,214.5 mi ²	96.3%
Inland Waters	1,526.4 mi ²	3.7%
Total Area	40,740.9 mi²	100.0%

includes urban areas. Inland waters account for the remaining 3.7%.

In summary, Virginia is fortunate to have abundant, diverse water resources. However, changing land use patterns and an expanding urban population are bringing new challenges to water pollution control. Clean water is a valuable resource to the citizens of the Commonwealth. The following chapters of this report describe existing water quality, and the various programs which are responsible for its protection and ultimate improvement.

Chapter 2.2 WATER POLLUTION CONTROL PROGRAMS

Virginia Pollutant Discharge Elimination System (VPDES)

The Commonwealth of Virginia has operated a successful state discharge permit program since 1946. To supplement state programs, the Federal Water Pollution Control Act was passed requiring a uniform permit program nationwide, allowing all States to uniformly control industrial and municipal wastewater discharges. Some states elected to have the federal government manage their permit program. Virginia requested delegation of authority from EPA to administer its own permit program in conformance with VPDES (formally NPDES) regulations. In April 1975, Virginia was delegated the authority to administer the VPDES permit program.

VPDES permits establish limits on the quantity and/or concentration of pollutants allowed in the discharge. The VPDES permits implement the applicable requirements of federal effluent guidelines, as well as the Virginia Water Quality Standards. Effluent limits are written to assure the most appropriate of these regulations is applied to the discharge. The permittee must monitor the quality of the effluent and report the results to the DEQ. The permit also requires the facility to be properly operated and maintained. Conditions requiring pretreatment programs are included in permits for publicly owned treatment works (POTWs) that are subject to this program. Other VPDES permits may contain requirements related to the control of pollutants in storm water.

The Toxics Management Program, (TMP) which is discussed in detail elsewhere in this report, is also implemented through the VPDES permits. DEQ is utilizing the concept of general permits to streamline the permitting process and conserve resources of both the permittee and DEQ.

Municipal Facilities

Currently 5,770 VPDES permits are in force in Virginia. Approximately 1,385 of these are general permits for sewage discharges less than or equal to 1,000 gallons per day. These permit holders are required to monitor their discharge and report the results to DEQ. There are 92 "major" municipal dischargers, discharging at least one million gallons per day (mgd). Major facilities range in size from one to 70 mgd and treat about 90 percent of all the sewage in Virginia.

Industrial Facilities

There are 587 industrial dischargers currently permitted in the state. Of these, 59 are major facilities. Facilities are assigned major and minor status annually through an agreement between the EPA and the DEQ.

General Permits

General permits are written for a general class of dischargers. Virginia was granted general permit authority from EPA in May, 1991. The impact of General Permits has streamlined the VPDES permit process, and reduced the paperwork, time and expense of obtaining a permit. It has also allowed staff resources to be concentrated on permits which have the greatest potential for impacting water quality. The processing of general permits requires the submittal of a Registration Statement. Upon staff review and acceptance of the Registration Statement, a General Permit is sent to the owner. Currently seven types of general permits, are available in Virginia: Corrective Action Plan, Confined Animal Feeding Operations, Storm Water, Nonmetallic, Mineral Mining, and Domestic Sewage Discharges less than or equal to 1,000 gallons per day and Non-Contact Cooling Water dischargers. Other General Permits in various stages of development are: Seafood Operations; Car Wash dischargers; and Ready Mix Concrete Operations (pending).

There are 4,397 dischargers covered by the general permits in force in Virginia. Of these permits, 2,758 have received coverage under one of the four Storm Water General Permits. Storm

Water General Permits are available for light and heavy manufacturing facilities; transportation facilities, landfills, power plants, recycling facilities; and construction sites.

Fees For Permits And Certificates

The DEQ has adopted Regulation VR 680-01-01 which establishes fee schedules for Permits. The assessment of fees is a requirement of Section 62.1-44.15:6 of Article 2.1 of the State Water Control Law enacted by the 1992 General Assembly. The assessment of fees allows DGIF, DCR, and DEQ to recover a portion of the cost of processing applications for permits or Certificates which DEQ has the authority to issue.

Fees have been established for VPDES, Virginia Pollution Abatement (VPA), Virginia Water Protection (VWP), Corrective Action Plan (CAP), Surface and Ground Water Withdrawals, and General Permits. Agricultural operations are exempt from payment of permit application fees. Fees may range from \$200 for a general permit to \$8,000 for a VPDES "Industrial Major" permit. There are also fees for modifications and waivers.

Toxics Management Program

Requirements for toxics monitoring are written into VPDES permits as special conditions. These monitoring requirements are developed by the DEQ Toxics Management Program (TMP), which originated in the early 1980's. Since November 1988, the program has been driven by Virginia's Toxics Management Regulation (VR 680-14-03). The aim of the program is to involve all industrial and municipal VPDES permit holders that potentially discharge toxic pollutants into a systematic program of biological testing. This testing is designed to identify wastewater discharges that are toxic to aquatic life.

The need for a TMP is determined at the time of permit issuance, reissuance, or modification, using information provided by the permittee as part of the VPDES permit application, as well as additional data generated by the DEQ or other sources. Generally TMP special conditions include quarterly chronic and/or acute toxicity testing for a period of one year using vertebrate and invertebrate species. Once the TMP data have been generated for a particular outfall, they are evaluated according to the following decision criteria specified by the Toxics Management Regulation:

1. The effluent test results must demonstrate no acute toxicity in at least 75% of the tests performed.
2. The effluent test results must demonstrate that no chronic toxicity would be predicted in the receiving stream under low flow conditions in at least 75% of the tests performed. (Chronic toxicity testing is only applicable to effluent predicted to make up at least 1% of the receiving stream during low flow conditions).

If an effluent passes decision criteria 1 and 2 above, annual toxicity testing is usually required for the remaining life of the permit. If an effluent demonstrates acute and/or chronic toxicity by failing criteria 1 and/or 2 above, the permittee is required to perform a toxicity reduction evaluation (TRE) and a whole Effluent Toxicity limit is developed for the VPDES permit. A TRE is a process for identifying specific toxicants or toxicant groups responsible for the effluent toxicity, and for evaluating and implementing treatment alternatives to reduce the toxicity to acceptable levels.

Pretreatment Program

The Pretreatment Program controls industrial discharges to POTWs. These municipal sewage treatment plants are not designed to treat toxic industrial wastes. Such wastes may interfere with the plant's biological treatment processes, pass through them untreated into receiving waters, or contaminate POTW sludge to the extent that lawful disposal is precluded. The control authorities for

the POTWs are charged with the responsibility of controlling their industrial users. Oversight and regulation of the POTW pretreatment programs was delegated to the DEQ by EPA on April 14, 1989.

There are 32 POTW authorities in Virginia with approved pretreatment programs. These authorities control 63 separate permitted treatment facilities. Pretreatment programs for three other authorities have been submitted for review or are under development. Requirements for sewer use ordinances, surveys of industrial users, or implementation of approved pretreatment programs are currently being incorporated into municipal VPDES permits.

Standards imposed on industrial users include general standards, prohibitive discharge standards, categorical standards, and local limits developed by POTWs. General standards are narrative prohibitions against pass-through and interference, applicable to all industrial users. Prohibitive discharge standards are also applicable to all industrial users and include limitations on parameters such as pH and temperature, measured in industrial discharges. Categorical standards are federal technology-based standards developed for certain categories of industries discharging to POTWs. In addition, POTWs are required to develop local limits for substances that have the potential to cause interference with treatment or pass through in toxic amounts to receiving waters.

A total of approximately 140 industries subject to federal categorical pretreatment standards are known to discharge to the POTW authorities noted above. In addition, there are approximately 200 other industries which are considered significant dischargers to these POTWs. These industries are classified as such by having process wastewater flows of at least 25,000 gpd.

The DEQ regional office personnel conduct audits of POTW pretreatment programs and inspections of their significant industrial users. They also inspect 13 additional categorical industrial users in small municipalities developing pretreatment programs or with unapproved programs. These users are controlled through municipal ordinances, and are required to self-monitor and report biennially to the municipality, which then reports to DEQ. The regional offices also review various pretreatment-related submittals from the POTWs.

Personnel at the DEQ central office write regulations, issue guidance, and provide technical support for the state Pretreatment Program. They serve as a secondary level of review for all major pretreatment program submissions, and provide guidance, technical assistance, and training to the regional and enforcement personnel. A "Pretreatment Procedures Technical Manual" has been developed, and is updated as part of this effort, in order to provide a central source of guidance to the regional offices and pretreatment POTWs. The central office section also updates required data elements for EPA's Permit Compliance System from information gleaned from POTW audits and annual reports.

The Virginia Compliance Auditing System

The DEQ monitors the performance of municipal and industrial dischargers through a computerized Compliance Auditing System (CAS), which was instituted in September 1987. Under the VPDES permit program, major facilities are required to submit monthly plant performance reports based upon self-monitoring of the parameters listed in the discharge permit. Minor facilities report on an individually assigned frequency. These discharge monitoring reports (DMRs) indicate the quality of plant effluent and whether any bypasses have occurred. Data from the DMRs are entered into the CAS in the regional offices, which compares all parameters to permit limits to detect any permit violations.

When a permit violation is observed through the CAS, the system assesses weighting points according to the severity and frequency of the violation. In addition to the automatic detection of permit effluent violations through the automated CAS, compliance schedules, both in permits and enforcement actions as well as other required due dates, are tracked through other databases and weighting points assigned for violations. Weighting points are also assigned for single event violations

reported to the DEQ by permittees, the public or other sources. All weighting point values are assessed and tallied for the previous six months. When accumulated values exceed specified limits enforcement action may be initiated if compliance cannot be immediately achieved. Enforcement action may also be initiated any time a violation is observed which is determined to cause environmental harm. Additional enforcement activity may result from problems discovered during on-site inspections.

The accumulated records of weighting point values are used by both Regional Office and Central Office staff as a tool to aid objective focus when determining appropriate enforcement activity with facilities in habitual permit noncompliance and on those facilities with the greatest potential for environmental harm. The program also ensures that permittees are fully aware of problems as they develop and have an opportunity to improve treatment in order to maintain compliance .

Virginia Pollution Abatement Permits

A Virginia Pollution Abatement (VPA) Permit may be issued by the SWCB whenever an owner handles waste or wastewaters in a manner that does not involve discharging to a sewage treatment facility or to state waters pursuant to a valid VPDES permit. Pollution abatement facilities approved through the VPA permit program may include pits, ponds, and lagoons for waste storage, treatment, or recycling. Permits are also required for on-site facilities, such as land treatment systems. The basis for approval for such systems includes assurance that waste or wastewater will not discharge directly into state surface waters under prescribed rainfall conditions, and for protection of ground water quality.

An owner who applies for a VPA permit is also required to provide conceptual plans for the pollution abatement facility. The application and plans are then reviewed and a site inspection is made. Whenever pits, ponds, or lagoons, and/or land treatment is proposed as part of the pollution abatement facility, it is determined if a potential threat to ground water quality exists. If so, the owner must supply site evaluation data and, possibly, a ground water monitoring program prior to receiving approval for a VPA permit.

The Virginia Pollution Abatement Permit Regulation (VR 680-14-01) was adopted on July 1, 1988. Prior to this regulation, the DEQ issued No-Discharge Certificates pursuant to Procedural Rule No. 2. With the adoption of the VPA permit regulation, Procedural Rule No. 2 was suspended and ultimately canceled. No-Discharge Certificates remain in effect until the owner is notified by the DEQ that an application for a VPA permit is required. Concurrent with the issuance of a permit, the No-Discharge Certificate is revoked subject to appropriate notice and opportunity for a hearing. To date, a total of 260 VPA permits have been issued. Due to the changes under the VPA regulation, it is estimated that 50 percent of the old certificates will be revoked without VPA permit issuance. Other industrial operations for which VPA permits are issued include timber products, textile, meat packing and rendering, food processing, chemical products, metal plating, petroleum products distribution, car washes, laundromats, mining, and others.

Land application is a major no-discharge alternative to conventional discharging systems. In addition to eliminating a direct discharge of pollutants to state waters, an added benefit is derived from the fact that, for waste generators, land treatment is frequently a cost-effective alternative. Landowners receive the benefits of economic incentives in the form of fertilizer savings and soil conditioner value.

In Virginia, the agricultural use of sewage sludge has become so popular with municipalities and farmers that approximately 50 percent of all sewage sludge generated in the State is returned to the land for agricultural use. Not only is this a cost-effective alternative to disposal for municipalities, but the current commercial fertilizer value to farmers is estimated to be over \$2 million annually. Sludge contractors apply sludge on approximately 15,000 acres annually and maintain an inventory of about 50,000 acres of approved sites. As more stringent pollution abatement technologies are

initiated to clean up the Chesapeake Bay, the amount of sludge handled is expected to increase significantly, requiring the technically and economically acceptable disposal option that land application affords. Land application of sewage effluent is also proving to be a sound alternative for treatment of other wastes, such as landfill leachates and industrial waste treatment sludges.

The increasing use of land treatment by industry and municipalities is an encouraging trend. It reflects a growing acceptance on the part of waste generators and regulators alike that it is not only a cost-effective alternative, but one which is a technically sound means of waste or wastewater utilization. As commercial fertilizer costs continue to increase and wastewater treatment requirements become more stringent, land application looks to be a favorable alternative for waste management for both the waste generator and land owner.

Water Quality Planning

DEQ uses Water Quality Management Plans (WQMPs), required by section 303(e) of the Clean Water Act, as the link between the water quality assessment required for this report and water quality based controls. These plans recommend control measures for the water quality problems identified and characterized in the 305(b) report. Control measures recommended in the plans are implemented through the VPDES permit system for point sources and through the application of Best Management Practices (BMPs) for nonpoint sources. WQMPs establish the strategy for returning impaired waters to meet water quality standards and for preventing the degradation of high quality waters.

Waterbodies are classified as effluent limited (E. L.) where water is known to meet state water quality standards after the application of technology-based effluent limits or other required controls. Waterbodies not meeting existing water quality standards after the application of technology-based effluent limits or controls are classified as water quality limited (W.Q.L.).

The DEQ uses the WQMPs to implement the total maximum daily load (TMDL) process required by Section 303(d) of the Clean Water Act. TMDLs are the allowable loadings or loading strategies for waterbodies classified as water quality limited. The TMDL process is a mechanism for integrating the point and nonpoint source loads contributing to the impairment of the waterbody. Only by controlling both sources of pollutants, can water quality be restored to the affected waterbodies.

Pollution Response Program

Pollution Response Program (PReP) was established to provide state response to pollution incidents which affect waters of the Commonwealth.

Regional offices maintain 24 hour PReP phone service to receive citizen pollution reports. After hours, weekends, and on holidays, these calls are received by the Emergency Operations Center (VAEOC) operated by the Department of Emergency Services. VAEOC forwards the information via electronic mail to the regional office PReP Coordinators and to the VDH. Regional investigators are prepared to investigate events that have the potential to cause adverse environmental effects on a 24-hour basis. Trained personnel are on call to investigate and assist when needed with coordinating remediation activities associated with oil pollution incidents, fish kills, underground storage tank (UST) incidents and a variety of other reported incidents.

Chapter 2.3

COST/BENEFIT ANALYSIS

Construction Grants.

The Federal construction grants program was initiated in 1958 to provide financial assistance to municipalities for the planning, design, and construction of publicly owned treatment works. Since then, the program has been an essential element in pollution control efforts, without which many localities would have been unable to provide wastewater treatment systems.

Through 1988, Virginia received approximately \$1.2 billion in federal appropriations for construction grants. These federal funds financed up to 75% of the total eligible cost of approximately 183 projects. The state contributed another \$52.3 million toward project costs, with the remainder coming from local sources. Total local investment in these projects is estimated at \$500 million.

Virginia Revolving Loan Fund.

In 1988, the conversion from a "grant" program to a "low-interest loan" program to provide financial assistance for the planning, design and construction of POTW's began. Prior to this conversion, the 1986 General Assembly created the Virginia Water Facilities Loan Fund, through which grant related loans could be made to local governments at or below current market interest rates for wastewater treatment improvements. Principal and interest repaid into the fund could then be reloaned again for additional projects. The Federal Water Quality Act of 1987 established a State Revolving Loan Fund Capitalization Grant Program which provided an legal avenue for states to convert federal grant monies into a State Revolving Loan Fund.

On June 10, 1988, Virginia became the first state in EPA Region III and the fifth state in the nation to receive authorization to administer a State Revolving Loan Program. Since then, Virginia has received federal capitalization grants in each fiscal year (FY's 88 through 97) totaling \$358,140,169. In addition, Virginia has provided \$71,628,035 to the program.

Federal law allows grant funds recovered through audit and grant closeouts to be reallocated and converted to revolving loan monies. Virginia has been aggressive in pursuing administrative closeout of previous EPA grant projects, and since 1987, has recovered more than \$30 million through this process. Table 2.3 - 1 summarizes Revolving Loan Fund status as of June 30, 1997.

Table 2.3 - 1 - Summary of Revolving Loan Fund Status

STATUS	NUMBER	AMOUNT
Loans Closed During Assessment Period	110	\$ 461,102,374.81
Loans Committed	18	\$ 69,190,528.00
Targeted For FY 1998	21	\$ 71,302,951.00
Total	149	\$ 601,595,853.81

The impact of Virginia's loan program on water quality and public health can be summarized as follows:

- Eliminated 12 primary dischargers

- Upgraded or replaced 25 inadequate lagoons
- Upgraded, expanded, or replaced 80 outdated treatment facilities
- Improved water quality at 38 locations by significantly reducing infiltration and inflow
- Corrected 21 potential health hazard situations through the elimination of failing septic systems, pit privies, and straight-line discharges
- Eliminated 96 raw sewage overflow points

In 1996, the General Assembly amended the Code of Virginia to provide financial assistance from the revolving loan fund to address malfunctioning or inadequate on-site wastewater disposal systems where public health or water quality concerns exist and where connection to a public sewer system is not feasible. As a result of the Code change, the On-site Wastewater Treatment Program was created.

DEQ, VRA and the Department of Health worked together to jointly develop implementation guidelines for this pilot program to make low-interest loans available to local governments. Localities could then lend the money to individual property owners or small business to repair or install septic systems, sand filters, mound systems or other innovative, alternative sewage treatment systems.

The On-Site Wastewater Treatment Program funding initiative will operate as a pilot program during fiscal years 1997 and 1998. During this pilot program effort, DEQ and VRA will work with the local governments and their citizens to develop and implement local funding plans. The pilot concept allows the greatest flexibility for considering new ideas especially in the development of the funding plans.

In FY 97, Congress appropriated \$50 million for the Rural Communities Hardship Grant Program. Virginia's share of this appropriation was \$1,376,300 to be used in conjunction with the revolving loan program as "hardship grants" for rural communities.

604(b), 104(b)(3), and Clean Lakes Grant Programs

Federal funds have been used for Water Quality Management Planning and Implementation projects. The funds have been split between the Planning District Commissions for watershed planning and educational activities, and Internal Special Projects and equipment acquisitions to facilitate water quality monitoring and assessment activities. Table 2.3 - 2 summarizes 604(b), 104(b)(3), and Clean Lakes grant activities for the period June 1992 through June of 1997.

Table 2.3 - 2 Summary of Water Quality Management Grants

YEAR	604(B)	104(B)(3)	CLEAN LAKES	YR TOTAL
1992-1993	\$401,657	NA	\$104,491	\$506,148
1993-1994	\$397,328	NA	NA	\$397,328
1994-1995	\$246,537	\$149,040	\$56,250	\$451,827
1995-1996	\$254,620	\$182,160	\$28,000	\$464,780
1996-1997	\$417,075	\$161,807	-0-	\$578,882

YEAR	604(B)	104(B)(3)	CLEAN LAKES	YR TOTAL
TOTALS	\$1,717,217	\$493,007	\$188,741	\$2,398,965

Nonpoint Source Expenditures

Expenditures for non-point source related program activities have totaled approximately \$54.77 million over the last ten years. Of this amount, \$7.94 million was expended during the last two fiscal years. These figures represent actual expenditures by the Department of Conservation and Recreation and do not include expenditures for non-point source programs of other state agencies. Estimates of expenditures prior to 1985 are not available.

Chapter 2.4 POLLUTION PREVENTION (P2)

Recognized as the most cost-effective form of environmental protection, pollution prevention (or P2) is an environmental management strategy that emphasizes the elimination or reduction of wastes at the source of generation. Traditional waste management techniques, such as treatment and disposal concentrate on managing wastes after they are generated. Treatment, handling, and disposal of wastes result in significant financial costs and involve regulatory and compliance issues. In addition, traditional treatment processes of one waste stream often result in transferring contaminants to another that also must be managed (such as treating an air emission with a scrubbing operation which results in a wastewater stream).

Through P2 techniques, companies can eliminate or significantly decrease the quantity and/or toxicity of their generated wastes. Companies can avoid the direct costs and long-term liabilities associated with producing and managing those wastes. Source reduction techniques often result in increased production efficiencies which can decrease raw material purchasing needs. Also, P2 techniques emphasize a multi-media approach which avoids transferring contamination from one media to another.

Wastes are essentially wasted raw materials, and P2 efforts strive to conserve the use of raw materials by using them as efficiently as possible. P2 or source reduction is distinguished from recycling and reuse efforts, because these management techniques involve waste handling, collection, and reprocessing into a new raw material or useable product. True source reduction eliminates the need and the costs associated with wastes handling.

Goals of P2

- Eliminate or reduce waste generation
- Reduce the toxicity of generated wastes
- Conserve natural resources and materials
- Prevent spills and accidental releases
- Prevent raw materials and product losses

P2 techniques are proactive approaches and solutions to waste management issues and problems. Categories include process efficiency improvements, materials substitution, inventory control, preventive maintenance, improved housekeeping, in-process recycling, and office waste reduction. These techniques may involve complex capital upgrades for new equipment and computerized automation of monitoring equipment. However, many P2 techniques are as simple as using less-toxic raw materials or changing certain facility procedures.

Categories of P2 Techniques

<u>Categories</u>	<u>Description</u>
Process Efficiency Improvements	Changes in process and/or equipment to produce less waste and use raw materials more efficiently.
Materials Substitution	Replacing hazardous chemicals with less toxic alternatives of equal performance.
Inventory Control	Reducing product losses due to product expiration and over-stocking; "first-in, first-out" and "on-time" inventory control will reduce wastes and losses due to expiration and decomposition of containers.

Preventive Maintenance	Any activities that prevent equipment failures and environmental releases such as spills, leaks, or air emissions.
Improved Housekeeping	Keeping a clean shop helps conserve resources by preventing product losses due to spills and accidents.
In-Process Recycling	When materials are redirected back into the production process.
Office Waste Reduction	Computer automation, use of 2-sided copies, and re-use of scrap paper reduces waste generation; use of energy efficient equipment reduces overall need for electricity generation which causes pollution.

Companies who utilize P2 approaches to waste management can realize the full costs associated with wasting by performing a waste assessment audit. Normal accounting procedures consider only the costs associated with disposal and possibly treatment. A waste assessment audit also considers the cost of raw materials wasted, the time associated with handling and environmental compliance, and long-term liability and coordination requirements. Once companies consider all of the costs associated with wasting, the financial benefits of pollution prevention projects often becomes clear.

- Reduced costs of:
 - ⇒Waste treatment and disposal
 - ⇒Raw materials purchases
 - ⇒Process operations
- Meeting or exceeding environmental requirements
- Reduce potential environmental liabilities
- Protect employee health and safety
- Protect the environment

Most major industries with environmental staffs are aware of and have implemented pollution prevention techniques. These companies are realizing the benefits of P2 techniques to help their bottom line and gain a competitive advantage over other companies in their market. Many companies have been able to decrease their generation of hazardous and other wastes to such an extent that they can avoid environmental regulations and requirements altogether, resulting in significantly decreased long-term liabilities and expenditures. Many companies, however, do not have trained environmental staff persons who are able to investigate P2 opportunities and industrial advancements.

DEQ's Office of Pollution Prevention

DEQ's Office of Pollution Prevention (OPP) is the state's central authority for pollution prevention techniques and is available to assist companies throughout the state. DEQ's OPP maintains a clearinghouse of resources and guidance materials specific to all industrial sectors and most business activities and OPP staff is available to provide technical consultation and on-site assistance to business, industry, and government entities. OPP staff can also help develop educational materials and provide employee training at a given facility, and OPP consultation and assistance is non-regulatory and confidential. DEQ's OPP promotes P2 activities statewide by providing technical assistance activities, through outreach efforts, and various other initiatives.

Technical Assistance

OPP staff provides technical assistance to business, industry, government, and citizens. OPP maintains an information library containing manuals, articles, videos, and other resources on the most

up-to-date P2 techniques and innovative products and approaches. In addition, the Internet provides access to an abundance of P2 information from other states and the federal government. OPP staff will research waste issues and problems and provide requestors with the information they need in a timely fashion.

OPP staff is also trained in performing on-site P2 opportunity assessments. These site visits are non-regulatory and confidential and can help companies identify potential solutions to their waste management problems. During site visits, OPP staff will tour the facility asking questions about production, the flow of raw materials, and other waste management issues in order to identify potential P2 opportunities. After an assessment, OPP staff researches issues further and provides suggestions for reducing wastes. Companies are under no requirements to implement OPP suggestions, and some suggestions may require additional consideration and research by the company. Because the visits are strictly voluntary, the majority of OPP's suggestions are intended to save the company money while protecting the environment.

Outreach

DEQ's OPP conducts outreach activities to promote the use of P2 as the preferred solution to waste management problems. Outreach consists of training, presentations, publications, and the Internet homepage.

Teaching employees to consider and value P2 is one of the most effective ways of implementing a P2 program and continuing to find P2 solutions. Therefore, OPP is available to help companies provide P2 training and/or design on-site employee training programs. OPP also sponsors training workshops and conferences and makes presentations whenever requested to provide both general and technical information to various other audiences.

OPP publishes various fact sheets, videos, and reports to provide guidance on issues that are relevant to Virginia businesses, government, and citizens. In addition, OPP publishes a quarterly newsletter entitled *Pollution Prevention Virginia*, which highlights companies who have successfully implemented P2, P2 products, and on-going projects by OPP and related programs. OPP also maintains an Internet webpage which provides access to many of its clearinghouse resources, links to other P2 Internet information sources, and direct e-mail to OPP staff.

P2 Initiatives/Partnerships

Initiatives

In support of its outreach activities and general promotion of P2, OPP is involved in various special projects and initiatives. A few of these include state agency P2 planning, regulatory integration, and Businesses for the Bay.

State agency P2 planning is a result of the General Assembly's House Joint Resolution 453 (1995) requesting state agencies to consider and implement P2 when practical. DEQ has coordinated a 3-year schedule of training and development and implementation of P2 plans for affected state agencies. Many agencies have made great strides in reducing their generation of waste streams while realizing cost savings.

Regulatory integration is the process by which OPP has attempted to incorporate P2 principles and training throughout DEQ's regulatory functions. By training permit writers, inspectors, and enforcement staff to identify potential P2 opportunities, DEQ regulatory staff can often encourage companies to make proactive changes which will keep them in compliance and save them money. At the least, regulatory staff should be able to make companies aware of opportunities for assistance through OPP or other assistance groups. As part of this education, OPP staff performs joint P2

assessment/compliance inspections to teach regulatory staff how to identify P2 opportunities. In addition, P2 projects are increasingly being used by enforcement personnel in the form of Supplemental Environmental Projects (SEPs) in lieu of certain fines and penalties.

Businesses for the Bay is a voluntary P2 initiative that is centrally coordinated by the EPA's Chesapeake Bay Program. Virginia's OPP and the state P2 offices from Maryland and Pennsylvania are promoting Businesses for the Bay as a program to encourage the reduced use of toxic chemicals and the generation of wastes. Program members annually make voluntary P2 commitments and report on their successes. The program also has created a business-to-business mentoring program to assist smaller companies in learning about P2 opportunities. Members receive periodic public recognition for their efforts and are eligible for various awards. To date, 94 Virginia businesses and government facilities have committed to the program.

Partnerships

DEQ's OPP strives to maximize its own efficiency in promoting P2 activities by leveraging itself through various partnerships with other technical service providers. OPP works in partnership with groups such as the National Pollution Prevention Roundtable, the Elizabeth River Project, the Virginia Philpott Manufacturing Extension Partnership, and the Center for Innovative Technology (CIT) to fund and sponsor events such as regional conferences, workshops, and a P2 grants program. In addition, OPP is networked with technical assistance groups such as the Small Business Development Centers, DEQ's Office of Small Business Assistance, and university programs across the state.

P2 and Water Quality

In the case of water pollution, DEQ's OPP works with municipal pre-treatment programs and directly with business and industry to encourage the voluntary use of waste reducing techniques as a means to minimize the quantity and toxicity of wastewater discharges and to facilitate regulatory compliance. Instead of constructing treatment facilities and paying wastewater disposal fees, industrial facilities can implement source reduction measures which can eliminate or significantly decrease their wastewater discharges. DEQ's OPP works with DEQ regional pre-treatment inspectors to encourage such measures as potential solutions to permit compliance difficulties, offering mutual benefits to municipalities, businesses, and water quality.

Many facilities have successfully reduced discharge fees or avoided the construction of treatment facilities and individual discharge permits by implementing in-process water recycling systems. Facilities benefit from significantly decreased costs for water usage, as well as disposal cost, and some facilities have even achieved "near-zero" discharge through the use of "closed loop" systems. As a general rule, separation of waste streams is the most effective technique for reducing wastewater discharges because it creates opportunities for on-site, in-process recycling. Other effective measures include counter-current rinsing, increased automation to provide increased production efficiency, substitution of less toxic chemicals/materials, installation of leak detection systems, preventive maintenance, and improved inventory control.

DEQ's Office of Pollution Prevention may be contacted at (804) 698-4235 or through the website "www.deq.state.va.us/opp/opp.html".

Chapter 2.5 PUBLIC HEALTH/AQUATIC LIFE CONCERNS

Increasingly, the DEQ is addressing the role toxicants play in reducing water quality in state waters, and supports programs to monitor, evaluate, and reduce toxicity to aquatic life and human health. Many of the programs in place at DEQ that address toxicity in state waters are described and discussed throughout this report.

The toxic pollutants that were monitored during the reporting period include toxic organics, metals and pesticides. Information on the state's monitoring programs and the results of this monitoring for toxics in water column, fish tissue, and sediment is provided in Chapters 3.1 and 3.3 of this report. A discussion of the methodology used to determine elevated levels of toxicants is provided in Chapter 3.2.

At the beginning of the reporting period, the State had in effect numeric surface water quality criteria for the protection of aquatic life for 34 substances, and surface water quality standards for mercury in fresh water, chlorine, and tributyltin. A human health standard for dioxin was adopted in September 1990. Virginia differentiates between standards and criteria, in that standards are always mandatory, while criteria may be modified on a case-by-case basis. In January 1992, the SWCB adopted mandatory surface water quality standards for the protection of aquatic life for 41 substances, and human health standards for 66 substances. These standards will greatly enhance the Department's ability to reduce toxicity in state waters through permitting and enforcement activities.

Numeric surface water quality criteria for the protection of aquatic life have been adopted, as of the end of the current reporting period, for the following 35 toxic substances:

Aldrin	Demeton	Methoxychlor
Ammonia	Dieldrin	Mirex
Arsenic	Endosulfan	Nickel
Cadmium	Endrin	Parathion
Chlordane	Guthion	PCB's
Chloride	Heptachlor	Pentachlorophenol
Chlorine	Hydrogen Sulfide	Selenium
Chlorpyrifos	Kepone	Silver
Chromium	Lead	TBT
Copper	Lindane	Toxaphene
Cyanide	Malathion	Zinc
DDT	Mercury	

Fishing Advisories and Restrictions

The VDH Bureau of Toxic Substances Information has five health advisories and one restriction currently in effect for fish consumption. The fish consumption advisory in the Jackson River and Upper James River due to dioxin, was lifted in 1993. Also, the fish consumption advisory which had been in effect for dioxin in the Blackwater and Nottoway Rivers has just recently been lifted. A fishing restriction allows sport fishing within the affected area, but the taking of fish for human consumption is prohibited. A health advisory warns of potentially dangerous levels of contamination found in fish tissues in an affected area and may suggest limited consumption but does not prohibit consumption. Under health advisories, the population at risk and a safe maximum consumption rate may be specified. These areas are described below. The advisories and restriction affect a total of 278 mainstem river miles.

Kepone in the Lower James River

From 1966 through 1975 Allied Chemical Company and its subsidiary Life Science Products, Inc. produced a persistent chlorinated hydrocarbon insecticide called Kepone. During production, an

estimated 90,720 kg of Kepone was released to the environment through atmospheric emissions, wastewater discharges, and bulk-disposal of off-specification batches. The James River and its tributaries from Richmond to Newport News were contaminated with Kepone. In 1975, the entire James River from the fall line at Richmond to the Hampton Roads/Norfolk Bridge Tunnel, including all tributaries, was closed to the taking of any shellfish and/or finfish because of Kepone. From 1975 through 1988 various Kepone bans were in place. In 1988, all James River fishing restrictions due to Kepone were allowed to expire as Kepone levels in fish remained below the U.S. Food and Drug Administration (FDA) action level of 0.30 ppm. This area is currently under a contaminant advisory, covering the mainstem James River and all tributaries from the fall line at Richmond to the Hampton Roads-Norfolk Bridge Tunnel.

DEQ has continually monitored Kepone levels in the James River since its identification in 1975. The major areas of concern were Kepone levels in the water column, finfish, and sediment of the James River and its tributaries, and in the ground water in Hopewell. After continuous non-detectable results, water column monitoring was discontinued in 1981. Kepone levels in finfish, ground water, and sediment have decreased since the onset of the problem. Continued monitoring will provide the state with an up-to-date portrayal of Kepone levels throughout the contaminated reach of the river. The waterbodies affected by this health advisory are: VAT-G11, VAT-G10, VAP-G08, VAP-G07, VAP-G04, VAP-G03, VAP-G02, VAP-G01, and VAP-J15.

Mercury in the North Fork Holston River

Eighty miles of the North Fork Holston River in southwestern Virginia were contaminated with mercury by releases from the Olin manufacturing operation in Saltville. Although the chemical plant closed in 1972, mercury levels in fish remain above FDA action levels, and the consumption of fish from this area is prohibited. Catch-and-release fishing is allowed. This health restriction includes waterbodies VAS-013, VAS-012, VAS-011, and VAS-010.

Mercury in the South River and the South Fork Shenandoah River

Mercury was released by E. I. DuPont de Nemours and Company, a synthetic fibers plant in Waynesboro, into the South River and South Fork Shenandoah River from 1929 to 1950. The contamination was discovered in 1977, and was found to have contaminated 103 river miles, from the plant to the Page/Warren county line. These areas remain under a health advisory for fish consumption due to mercury contamination. The VDH recommends that no more than one meal (½ pound) per week of fish from these waters be consumed. Small children and pregnant women are advised not to consume any fish containing mercury. This health advisory is located in all or a portion of waterbodies, VAV-B40, VAV-B38, VAV-B37, VAV-B35, VAV-B33, and VAV-B32.

PCBs in the South Fork Shenandoah River, North Fork Shenandoah River, and Shenandoah River

The VDH has issued a public health advisory warning against the consumption of fish taken from the South Fork Shenandoah River from the State Route 619 bridge downstream to the Shenandoah River headwaters; from the North Fork Shenandoah River at its confluence with Passage Creek downstream to the Shenandoah River; and from the Shenandoah River from the confluence of the North and South Fork Shenandoah Rivers to the Virginia/West Virginia state border. This covers approximately 45 stream miles. This advisory was issued after DEQ monitoring revealed PCB levels in fish tissue samples above the 2.0 ppm FDA action level. The source of this contamination has been identified as Avtex Fibers Front Royal Inc. This plant closed in 1989 following revocation of their VPDES permit. This health advisory is located in waterbodies VAV-B58, VAV-B57, VAV-B55, VAV-B51, VAV-B41.

PCB in the Roanoke River

A health advisory for fish consumption has been issued for a 50 mile stretch of the Roanoke

River running through Cambell, Charlotte, Halifax and Pittsylvania counties. Polychlorinated biphenyls, commonly known as PCBs, have been detected in fish tissues of striped bass, white bass and carp. The advisory has been issued from Seneca Creek at Route 704 near Long Island downstream to the point where a pipeline intersects Route 803 and where Route 633 in Charlotte county crosses the Roanoke River (approximately 5.4 river miles below the route 360 bridge). People should eat no more than two eight-ounce meals a month of these fish species. These meal estimates are based on the possibility that eating PCB-contaminated fish may increase the risk of cancer in humans. The source of the contamination is unknown. Affected waterbodies are VAW-L30, VAW-L31, VAP-L36, VAP-L38, VAP-L40, VAP-L75 and VAP-L80

Tributyltin

Surface water samples were collected and analyzed by the Applied Marine Research Laboratory at Old Dominion University for the determination of the concentration of tributyltin (TBT) at one station in the Hampton Roads Harbor area and eleven stations in the Elizabeth River area of the lower James River. The samples were collected during six monitoring events over the period of June 1993 to March 1995. In-stream concentrations were compared to the Virginia Water Quality Standard for TBT in saltwater surface waters (VR680-21-01.13) which are not at any time to exceed 0.001 parts per billion (ug/l) TBT. The station in the Hampton Roads Harbor area did not exceed the standard. Six of the eleven stations in the Elizabeth River area exceeded the standard for TBT. The distribution of stations exceeding the TBT standard are as follows: three stations in the Elizabeth River main stem, one station in the Eastern Branch Elizabeth River, and two stations in the Southern Branch Elizabeth River. The exceedances occurred in segments which support considerable commercial vessel traffic with TBT hull coatings.

Shellfish Condemnations

The Virginia Department of Health has prohibited and/or condemned harvest of approximately 140 square miles of productive shellfish areas in the waters of Virginia. Another 6 square miles have been seasonally condemned, which restricts direct harvesting from 1 April to 31 October of each year. These areas are all located in the Chesapeake Bay and Tidewater areas of the state, and include waters surrounding certain point source discharges, as well as areas with elevated fecal coliform bacteria concentrations or other problems. Shellfish may be harvested from most restricted areas; however, they must first be relayed to approved waters for depuration for 15 days before marketing. Relaying is only allowed when the water temperature is above 50°F. The taking of shellfish is prohibited in three bodies of water: the Elizabeth and Lafayette Rivers, both within the lower James River subbasins; and Little Creek in the Small Coastal and Chesapeake Bay Basin.

Fish Tissue Contamination

The fish tissue monitoring program collects and analyzes fillet and whole body fish samples from stations located throughout the state. The objective of this program is to systematically assess and evaluate water bodies of the Commonwealth to identify areas where toxic contaminant accumulation has the potential of adversely affecting human health or the biological community.

The data generated by this program are evaluated utilizing EPA risk based screening values which incorporate the following assumptions: (1) general population adults; (2) body weight 70 kg; (3) risk level 10^{-5} ; and (4) consumption rate 0.0065 kg/day. The methodology and equations follow the EPA Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories (1994).

At the majority of stations, the levels of lead detected in fish tissue met or exceeded the EPA calculated human health risk based screening values for fish tissue. Based on the data and historical information, it has been recommended that further investigation is warranted to document the extent of this contamination.

At three stations (Pamunkey River, Mattaponi River, and lower James River), PCBs were detected at levels which exceeded the EPA calculated human health risk based screening value. These stations are being reviewed for further evaluation.

Chlordane was detected at levels exceeding the EPA calculated human health risk based screening value in striped bass from the lower James River. This station has also been recommended for further evaluation.

Mercury was detected, equaling the EPA calculated human health risk based screening value, in striped bass from the Mattaponi River station. Further sampling and evaluation is planned for the upcoming assessment period.

The Fish Tissue Monitoring Program reports have been forwarded to the Virginia Department of Health and the Virginia Department of Game and Inland Fisheries for their analysis, comment and management action. Additional information on fish tissue monitoring can be found in Chapter 3.1.

Fish Kills/Abnormalities

DEQ regional offices responded to several fish kill incidents affecting State waters during the summer of 1997. These incidents appeared to be related to a potentially toxic microorganism *Pfiesteria piscicida* which was originally identified in North Carolina. A great deal of effort on the part of several state agencies and universities has been put into trying to confirm the existence of this microorganism in Virginia's waters. Similar effort has been put into trying to understand the life cycle and the mechanism involved in the massive fish kills associated with this organism.

In August 1997, approximately 10,000 fish were found dead in Maryland's Pocomoke River and fish with body lesions were also reported. Maryland officials closed the upper Pocomoke River because it is believed that direct contact with water during a *Pfiesteria piscicida* outbreak can cause human health problems. Later in the month 2,000 dead fish (menhaden) were found in the Virginia portion of the river and it was also closed for several weeks.

Pfiesteria piscicida, a dinoflagellate, has a very complex life cycle which includes 24 distinct life forms. It can thrive as an active, free-swimming animal, an amoeba-like form or as a dormant, sediment dwelling cyst. Researchers have found 10 different *Pfiesteria*-like species that closely resemble each other. They are extremely difficult to distinguish from each other without the aid of an electron microscope. Scientists have grouped these similar species into a category known as Pfiesteria complex organism (PCO). It includes two *Pfiesteria* species (*piscicida* and one unnamed species) and several species not of the genera *Pfiesteria*. Three of these PCO's are known to be capable of producing toxicity toward fish. A *Pfiesteria*-like organism was found in samples taken from the Rappahannock and Great Wicomico rivers but it has not yet been determined which PCO they are.

Under certain environmental conditions that are not yet fully understood, and only in the presence of live fish, lab experiments have shown that *Pfiesteria piscicida* do release toxins. Researchers propose that upon stimulation from the appropriate cues (fish excretions, nutrient conditions, lack of mixing, salinity, etc.), *Pfiesteria piscicida* cysts are activated, emerge from sediments as free-swimming forms and release toxins. The toxins attack the nervous system which make the fish lethargic causing them to remain in the area where additional toxin damage can occur. The toxins also cause sloughing of the skin and subsequent lesions.

The free-swimming form of *Pfiesteria* feed on the blood and tissue from the open sores, and eventually the fish die. The lesions and fish kills in Maryland's upper Pocomoke River have been linked to *Pfiesteria piscicida*. Samples from Virginia waters sent to laboratories in North Carolina and Florida for analysis and culture thus far have proved negative.

Virginia scientists were vigilant last summer as reports of fish with lesions came in from fisherman. While lesions can be an indicator of a *Pfiesteria* outbreak, they can develop on fish for

many possible reasons. Physical injury from nets or traps, bites by other fish or birds, toxic chemicals, and infectious disease agents such as viruses, bacteria and fungi can all cause lesions. When the skin or mucus barrier of a fish is broken, the area is usually colonized rapidly by bacteria and fungi which further erode the tissue. Assessing the original cause of a lesion is extremely difficult unless an obvious parasite is present.

Actions DEQ and other Virginia agencies have taken

The Virginia *Pfiesteria* Task Force was formed in June 1997 to provide scientific guidance and a reasoned approach to the threat. Members include the Virginia Marine Resources Commission (VMRC), Virginia Department of Health (VDH), the Virginia Department of Environmental Quality (DEQ), and researchers from the Virginia Institute of Marine Sciences (VIMS) and Old Dominion University (ODU). When the fish kill occurred on August 26th in the Virginia portion of the Pocomoke River, the state responded quickly in a coordinated and comprehensive fashion with the following actions:

- \$800,000 was pledged by the Governor to investigate the issue and Virginia has entered into a cooperative agreement with governors from five other mid-Atlantic states to combat *Pfiesteria* regionally.
- DEQ collected samples of water, sediments and fish for analysis by leading authorities from ODU and VIMS, as well as NC State University and the Florida Marine Research Institute, leading authorities on the organism.
- DEQ contracted ODU to examine the presence of *Pfiesteria* in sediments of the lower Chesapeake Bay, James River, York River, and Rappahannock River.
- Task Force members researched the nature and distribution of fish lesions to determine the presence of *Pfiesteria* and other potentially toxic microorganisms in the Virginia portion of the Bay.
- Scientists continued to monitor the Pocomoke River and the Rappahannock River after receiving reports of lesioned fish.
- The Virginia Department of Health asked all Eastern Shore physicians to report any related illnesses.

Relationship between *Pfiesteria* and water quality

Popular press reports have linked *Pfiesteria piscicida* with nutrient enriched waters and suggest manure from animal rearing and processing operations as a source of the nutrient enrichment. This possible connection is still largely unknown because of the complexity of the life cycle associated with the organism. *Pfiesteria piscicida* and *Pfiesteria-like species* are normally nontoxic animals that eat bacteria, algae, and dissolved organic nutrients. It appears they only become toxic when they detect substances excreted/secreted by large concentrations of live fish and other possible environmental stimuli. Researchers hypothesize that the optimal conditions for a fish kill is a poorly flushed estuarine area protected from strong winds and wave action which would mix the water and dilute both fish excreta and the toxins released by the microbe.

Since *Pfiesteria piscicida* is an animal and not a plant, it seems less likely to respond directly to nutrient enrichment. Its preferred food is algae and one might expect *Pfiesteria* to be present where algae is abundant. Excess nitrogen and phosphorus stimulate algae blooms therefore, it could be indirectly linked to nutrient enrichment through its preferred food supply. For this reason, researchers speculate that poorly flushed areas with high nutrient levels might be more susceptible to outbreaks.

In general, the Chesapeake Bay and its tributaries are not considered, by many, as nutrient enriched as the Pamlico Sound and other estuarine tributaries in North Carolina where *Pfiesteria piscicida* is known to have caused large fish kills (10^3 and 10^9). There is little documented research on the topic and only a few scientific experiments conducted which indicate nutrient enrichment as a possible stimulus to *Pfiesteria piscicida*. Dr. Eugene Bureson, director for research and advisory services at the Virginia Institute of Marine Science (VIMS) suggests that hydrodynamic conditions may explain why low populations of *Pfiesteria* can exist without causing fish kills or human health problems. Until more research results are available, it is not possible to say with confidence why *Pfiesteria piscicida* outbreaks occur where they do and why they become toxic when and where they do. Additional research is planned for the summer of 1998 and DEQ will be directly involved in collecting samples during any associated fish kills in Virginia waters.

Reporting fish kills or fish with lesions

DEQ has responsibility for investigating fish kills and reports of fish with lesions in Virginia waters. Call 1 (800) 592-54VA to be directed to the appropriate regional office. Once reported, DEQ collects water samples for oxygen and other chemical parameters along with actual fish samples. Water samples are sent to ODU for analysis and fish samples are sent to VIMS. For any health related concerns, call the VDH hotline at 1 (888) 238-6154.

For additional information:

www.vims.edu/welcome/news/pfiesteria
www2.ncsu.edu/unity/lockers/project/aquatic_botany/pfiest.html
www.gateway-va.com/pages/fish/1030fish.htm
www.gacc.com/dnr
[www.mdsg.umd.edu/fish-health\(pfiesteria\)](http://www.mdsg.umd.edu/fish-health(pfiesteria))